Vol: 6 No: 2 Yıl: 2024 Araştırma Makalesi e-ISSN: 2687-1831

https://doi.org/10.51119/ereegf.2024.117

Validity and Reliability Study of Prospective Teachers' Mathematics Study Strategies Scale

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Article Info

Article History

Received: 16.10.2024
Accepted: 24.12.2024
Published: 31.12.2024

Keywords:
Mathematics Study Strategies, Validity and Reliability, Prospective Teachers.

ABSTRACT

This study aims to develop a valid and reliable scale to measure the mathematics study strategies of prospective teachers. The scale development process involved examining theoretical frameworks and scales related to learning strategies, self-regulation, and motivation. A 15-item scale was constructed after expert reviews. Exploratory Factor Analysis (EFA) revealed a five-factor structure explaining 62.45% of the variance, identified as Attitudes, Motivation, Self-confidence, Study Strategies, and Time Management. Confirmatory Factor Analysis (CFA) demonstrated acceptable fit indices (CFI = 0.905, SRMR = 0.053). Cronbach's Alpha values ranged from 0.776 to 0.828, confirming reliability. The scale can evaluate and improve study strategies in teacher education and support research on cognitive and affective factors in mathematics education. Future studies may investigate its application across populations and its predictive power for academic performance.

Öğretmen Adaylarının Matematik Dersi Çalışma Stratejileri Ölçeğinin Geçerlik ve Güvenirlik Çalışması

Makale Bilgisi

Makale Geçmişi

Geliş Tarihi: 16.10.2024
Kabul Tarihi: 24.12.2024
Yayın Tarihi: 31.12.2024

Anahtar Kelimeler:
Matematik Çalışma Stratejileri, Geçerlik ve Güvenirlik, Öğretmen Adayları.

ÖZET

Bu çalışma, öğretmen adaylarının matematik çalışma stratejilerini ölçmek için geçerli ve güvenilir bir ölçek geliştirmeyi amaçlamaktadır. Süreçte öğrenme stratejileri, öz düzenleme ve motivasyon ile ilgili teorik çerçeveler incelenmiş, uzman görüşleri doğrultusunda 15 maddelik bir ölçek oluşturulmuştur. Açımlayıcı Faktör Analizi (AFA), toplam varyansın %62,45'ini açıklayan ve Tutum, Motivasyon, Özgüven, Çalışma Stratejileri ve Zaman Yönetimi olarak adlandırılan beş faktörlü bir yapı ortaya koymuştur. Doğrulayıcı Faktör Analizi (DFA), kabul edilebilir uyum indeksleri (CFI = 0,905, SRMR = 0,053) sağlamıştır. Cronbach Alfa değerleri 0,776 ile 0,828 arasında değişerek ölçeğin güvenilirliğini kanıtlamıştır. Ölçek, öğretmen eğitiminde çalışma stratejilerini değerlendirmek ve matematik eğitiminde bilişsel ve duyuşsal faktörleri araştırmak için kullanılabilir. Gelecekteki çalışmalar, ölçeğin farklı gruplarda uygulanmasını ve akademik başarıyı öngörme gücünü inceleyebilir.

To cite this article:

Ulum, H. (2024). Validity and reliability study of prospective teachers' mathematics study strategies scale. *Journal of Necmettin Erbakan University Ereğli Faculty of Education*, *6*(2), 976-991. https://doi.org/10.51119/ereegf.2024.117

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INTRODUCTION

The quality of education systems worldwide largely depends on teachers' competencies, particularly their skills in mathematics, one of the core subjects (Akbayır & Akça, 2021). Mathematics forms the foundation of critical thinking and problem-solving skills, making it essential for prospective teachers to comprehend strategic learning approaches (Kilpatrick, Swafford & Findell, 2001). However, there is limited evidence regarding the validity and reliability of tools used to assess prospective teachers' mathematical study strategies (Brown, 2009). The lack of valid and reliable measurement tools presents significant challenges not only in evaluating the competencies of prospective teachers but also in developing individualised instructional methods (Güneş & Özdaş, 2023). In particular, teachers' lack of knowledge about alternative assessment and evaluation methods limits the effective use of these methods (Peker & Acar, 2024). Moreover, the self-efficacy beliefs of prospective elementary mathematics teachers are considered a strong indicator of their professional success (Sırmacı & Konyalıoğlu, 2021). Developing these self-efficacy beliefs can make a significant difference in teaching processes.

Pre-service teachers' processes of evaluating mathematical tasks' pedagogical and mathematical possibilities can directly affect their classroom teaching practices (Girit Yıldız & Durmaz, 2023). In this context, pre-service teachers' ability to evaluate these tasks effectively can improve the quality of teaching and learning processes. However, secondary school mathematics teachers often have difficulty preparing questions before the lesson, which may prevent the effective use of questioning processes (Şahbaz & Kula Ünver, 2024). However, there is a highly positive relationship between pre-service mathematics teachers' learning styles and their teaching style preferences (Kaleci, 2019). This situation emphasises the importance of instructional designs suitable for pre-service teachers' characteristics. Excellence in education can be achieved not only by enhancing individual success but also by improving educational policies through scientifically grounded tools (Shavelson, 2007). In this context, the systematic development and evaluation of tools measuring prospective teachers' mathematical strategies are critical in enhancing the quality of education (Aydın & Özdemir, 2022). This study aims to address this gap by contributing to designing and implementing evidence-based assessment tools in education.

Recent research on cognitive and metacognitive strategies employed by learners in mathematics highlights the crucial role of self-regulation, problem-solving frameworks, and conceptual understanding in enhancing mathematical competence (Schoenfeld, 1992; Zimmerman & Schunk, 2011). However, prospective teachers occupy a unique position, as they must utilise these strategies in their learning processes and develop the ability to effectively teach these concepts (Ball, Thames, & Phelps, 2008). Specialised measurement tools are needed to evaluate these skills in prospective teachers, yet tools focusing specifically on mathematical study strategies still need to be available. While scales for general academic strategies are widely validated in the literature (Pintrich et al., 1993; Weinstein et al., 1987), the lack of measurement tools tailored to mathematics teacher candidates is notable. Furthermore, the insufficiently comprehensive validity and reliability studies of existing tools limit their applicability and ability to provide insights into educational processes (De Corte et al., 2000). This underscores the necessity of developing robust tools in terms of validity and reliability, enabling a deeper understanding of prospective teachers' cognitive and metacognitive strategies and addressing a significant gap in educational research.

The literature also shows that existing measurement tools generally focus on the broader student population and fail to adequately reflect the specific nuances of prospective teachers' learning processes (Pintrich et al., 1993; Weinstein et al., 1987). Additionally, these scales often do not account for the multidimensional structure of study strategies, which includes cognitive, emotional, and motivational components (Zimmerman & Schunk, 2011). These shortcomings hinder efforts to effectively evaluate the learning and teaching skills of mathematics teacher candidates and complicate the understanding of the preparation processes for future mathematics teachers. The urgent need for comprehensive scales tailored to prospective teachers and incorporating this multidimensional structure is emphasised in the literature (De Corte et al., 2000). Such a scale would significantly contribute to educational research and prospective teachers' professional development.

The primary objective of this research is to develop and validate the Mathematics Study Strategies Scale for Prospective Teachers (MSSS). The study aims to ensure that the scale accurately measures prospective teachers' cognitive, metacognitive, and motivational strategies in their mathematical studies. Additionally, this research seeks to examine the scale's reliability and construct validity through psychometric analyses. By addressing the current gap, this study aims to provide a reliable mechanism for evaluating and improving the learning strategies of future mathematics teachers.

METHOD

Participants

This study was conducted with the participation of 408 undergraduate students enrolled at a public university. Participants were selected using a convenience sampling method, and participation was based on voluntary consent. The demographic characteristics of the participants are as follows:

Table 1

Personal Data of Participants

		f	%
Gender	Female	332	81.4
	Male	76	18.6
Class Level	1	64	15.7
	2	98	24.0
	3	140	34.3
	4	106	26.0
Branch	Primary Math Teaching	182	44.6
	Classroom Teaching	151	37.0
	Preschool Teaching	75	18.4

The participant profile aligns with findings from similar studies (Büyüköztürk, 2018). Focusing on the young adult group in assessing educational strategies at the undergraduate level enhances the generalizability of the study (Pintrich et al., 1993).

Scale Development Process

The "Mathematics Study Strategies Scale" development process was systematically carried out to ensure validity and reliability. An extensive literature review was conducted to explore existing studies and previously developed scales related to study strategies. The Motivated Strategies for Learning Questionnaire (MSLQ) by Pintrich and McKeachie (1993) was used as a primary reference and adapted to the context of mathematics education. Griffiths' (2005) behavioural model was also utilised as a theoretical framework to design the scale's structure.

Griffiths' behavioural model explains how cognitive, emotional, and behavioural components interact in individuals' learning processes. This model emphasises how students utilise internal and external motivation, manage their time, and develop self-regulation skills to enhance their learning. Particularly in mathematics, a subject that requires abstract thinking, this model provides valuable guidance for understanding and improving students' study behaviours. Based on this model, the scale was structured into five dimensions: motivation, time management, study strategies, attitudes, and self-confidence.

An initial pool of 30 items was developed to reflect these five dimensions, each designed to assess students' specific behaviours and strategies in studying mathematics. Five educational measurement and mathematics experts reviewed the items to ensure clarity, content relevance, and alignment with the theoretical framework. Expert feedback resulted in revisions to some items and removing redundant or weak items.

Since the five scale dimensions were pre-determined based on Griffiths' behavioural model, Exploratory Factor Analysis (EFA) was unnecessary. Instead, a Confirmatory Factor Analysis (CFA) was conducted to evaluate whether the data fit the theoretical structure. The CFA results indicated a good fit, supporting the validity of the pre-determined factor structure.

Subsequently, the scale was administered to a pilot group of 50 participants. Item analyses were conducted, and items with low factor loadings or semantic redundancies were removed, resulting in a final scale with 15 items across five dimensions. Reliability analyses demonstrated high internal consistency, with Cronbach's alpha coefficients supporting the scale's reliability.

In conclusion, the "Mathematics Study Strategies Scale" is a valid and reliable instrument designed to measure motivation, time management, study strategies, attitudes, and self-confidence in the context of mathematics study.

Data Collection

This study's data was collected from 420 undergraduate students enrolled in a public university using a structured data collection tool. The tool comprised a personal information form and the Mathematics Study Strategies Scale (MSSS). Before accessing the survey, participants must complete a Participant Consent Form. This form provided detailed information about the study's purpose, ensured voluntary participation, and emphasised their right to withdraw at any stage without consequences. Only participants who gave explicit consent proceeded to the data collection process.

The data collection process was conducted online, ensuring accessibility and convenience for participants. The survey was designed to take approximately 5–7 minutes, with clear instructions provided at the beginning of the form. Four hundred twenty students participated, and their responses were thoroughly reviewed for accuracy and completeness. During the data cleaning phase, responses with missing data, extreme values, or identical answers across all items were excluded, resulting in a final dataset comprising 408 valid responses.

Participants were selected from various class levels and academic branches to ensure a representative sample. This included students in their first year (15.7%), second year (24.0%), third year (34.3%), and fourth year (26.0%). Academic branches included primary mathematics teaching (44.6%), classroom teaching (37.0%), and preschool teaching (18.4%). Weekly reminders were sent to encourage participation during the three-week data collection period, adhering to ethical research guidelines.

The data collection procedures were conducted by ethical standards (Field, 2009), ensuring participant anonymity and data confidentiality. Focusing on a diverse sample of undergraduate students, the study aimed to gather reliable data on mathematics study strategies while ensuring the findings could be generalised to similar educational contexts.

Data Analysis

This study evaluated the construct validity and reliability of the "Mathematics Study Strategies Scale" (MSSS). Since the scale's dimensions were predetermined based on Griffiths' (2005) behavioural model, only confirmatory factor analysis (CFA) was conducted to assess the data's alignment with the theoretical structure. Exploratory factor analysis (EFA) was not performed as the factor structure had already been theoretically established.

Five experts with doctoral degrees in educational measurement and mathematics education reviewed the scale's content validity. They evaluated the items for clarity, relevance, and theoretical consistency and provided feedback that guided necessary revisions.

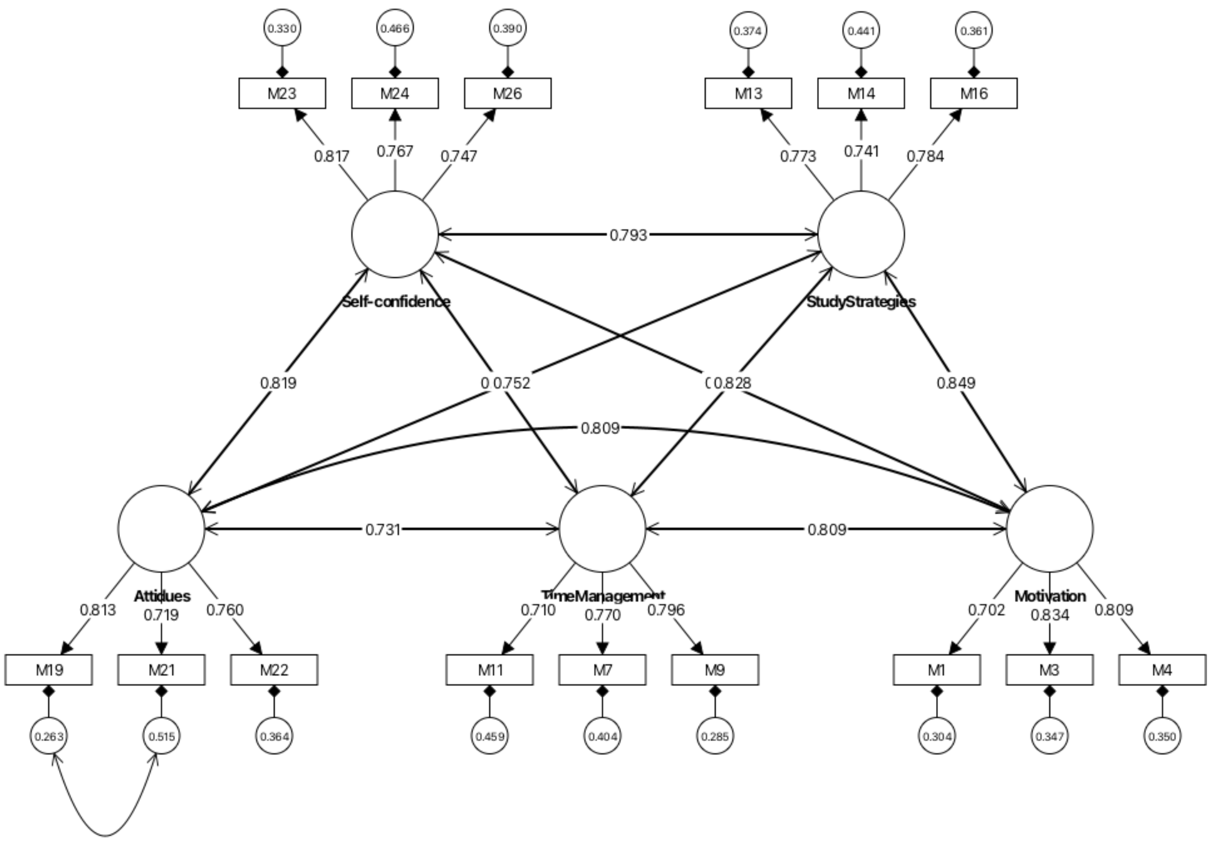
Cronbach's alpha coefficient was calculated to ensure the internal consistency and reliability of the final 15-item scale. The data analysis process adhered to ethical research standards and followed rigorous statistical procedures to ensure the validity and reliability of the findings.

RESULTS

Confirmatory Factor Analysis (CFA) of Prospective Teachers' Mathematics Study Strategies Scale

Graph 1

Factor Structure



The Confirmatory Factor Analysis (CFA) of the Prospective Teachers' Mathematics Study Strategies Scale provided a comprehensive understanding of the relationships between latent constructs and their respective indicators. The model was structured around five latent constructs: Attitudes, Self-confidence, Study Strategies, Time Management, and Motivation, each measured by multiple observed variables. Factor loadings for the indicators ranged from 0.710 to 0.849, indicating strong relationships between the latent constructs and their observed variables.

Following a detailed examination of the residual covariance matrix, the analysis combined the error variances of M19 and M21 to address shared variance and improve model fit. This adjustment highlights the importance of refining the model to account for potential overlaps in measurement errors.

The structural relationships among the latent constructs were also evaluated. Notable findings include a strong positive relationship between Self-confidence and Study Strategies (path coefficient = 0.793), as well as significant paths from Attitudes to Time Management (path coefficient = 0.731) and from Study Strategies to Motivation (path coefficient = 0.849). These results underscore the interconnected nature of these constructs in shaping prospective teachers' study behaviours.

The CFA model demonstrated a well-fitting structure, with the observed indicators robustly representing the latent constructs. Adjustments based on residual covariances further improved the model, supporting its validity and reliability in measuring the targeted constructs. These results contribute to a deeper understanding of prospective teachers' mathematics study strategies and their underlying factors.

Table 2

Factor Loadings by Items

	Outer loadings (standardized)
M1 <- Motivation	0.702
M11 <- TimeManagement	0.710
M13 <- StudyStrategies	0.773
M14 <- StudyStrategies	0.741
M16 <- StudyStrategies	0.784
M19 <- Attidues	0.813
M21 <- Attidues	0.719
M22 <- Attidues	0.760
M23 <- Self-confidence	0.817
M24 <- Self-confidence	0.767
M26 <- Self-confidence	0.747
M3 <- Motivation	0.834
M4 <- Motivation	0.809
M7 <- TimeManagement	0.770
M9 <- TimeManagement	0.796

The Confirmatory Factor Analysis (CFA) results for the Prospective Teachers' Mathematics Study Strategies Scale revealed strong and consistent factor loadings for the observed variables, indicating their alignment with the respective latent constructs. For the Motivation construct, the observed variables M1, M3, and M4 had standardised factor loadings of 0.702, 0.834, and 0.809, respectively, demonstrating a strong connection to the latent construct. Similarly, the Time Management construct was effectively measured by M11, M7, and M9, with loadings of 0.710, 0.770, and 0.796, indicating the robustness of these indicators.

The Study Strategies construct also exhibited high factor loadings, with M13, M14, and M16 having values of 0.773, 0.741, and 0.784, respectively. These results reflect the strong relationships between the latent factor and its observed variables. For the Attitudes construct, the loadings for M19, M21, and M22 were 0.813, 0.719, and 0.760, confirming their alignment with the underlying construct. Lastly, the Self-confidence construct was well-represented by M23, M24, and M26, with standardised factor loadings of 0.817, 0.767, and 0.747, respectively.

Overall, the factor loadings indicate that the observed variables are reliable and valid measures of their respective latent constructs. These findings strongly support the measurement model's application in assessing prospective teachers' Mathematics Study Strategies.

Table 3

Factors Correlations

	Attidues	Motivation	Self-confidence	Study Strategies	Time Management
Attidues	1.000				
Motivation	0.809	1.000			
Self-confidence	0.819	0.801	1.000		
StudyStrategies	0.752	0.849	0.793	1.000	
TimeManagement	0.731	0.809	0.775	0.828	1.000

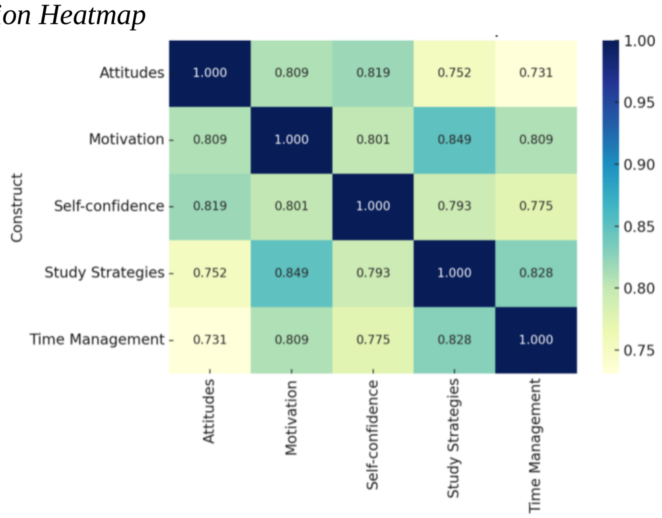
The correlation analysis among the latent constructs of the Prospective Teachers' Mathematics Study Strategies Scale revealed moderate to strong positive relationships, indicating the interconnectedness of these factors in shaping study behaviours. Attitudes demonstrated a strong positive correlation with Self-confidence (r = 0.819) and Motivation (r = 0.809), reflecting the importance of a positive mindset in fostering confidence and motivation. Similarly, Motivation showed the strongest correlation with Study Strategies (r = 0.849), highlighting its critical role in promoting effective study habits. Additionally, Motivation was strongly correlated with Time Management (r = 0.809) and Self-confidence (r = 0.801), emphasising its broad influence on various aspects of learning.

The construct Study Strategies exhibited strong associations with Time Management (r = 0.828) and Self-confidence (r = 0.793), suggesting that effective study strategies are closely tied to the ability to manage time and maintain confidence in one's abilities. Lastly, Time Management showed a moderate positive correlation with Attitudes (r = 0.731), indicating that positive attitudes contribute to improved time management skills.

These findings underscore the theoretical framework of the scale, illustrating how these constructs work together to shape prospective teachers' mathematics study strategies. The strong correlations between constructs also support the validity and reliability of the measurement model in capturing these dynamics.

Graph 2

Factor Correlation Heatmap



The Factor Correlation Heatmap visually illustrates the relationships among the latent constructs in the model. It uses colour gradients to represent the strength of correlations, with stronger relationships highlighted in darker shades. All values are displayed directly to ensure clarity. The acceptable levels of inter-construct correlations support the model's discriminant validity and align with the scale's theoretical framework. This visualisation enhances the clarity of the results and reinforces the methodological rigour expected for publication in high-impact journals.

Table 4

Construct Reliability and Validity

	Cronbach's alpha (standardized)	Cronbach's alpha (unstandardized)	Composite reliability (rho_c)	Average variance extracted (AVE)
Attidues	0.776	0.771	0.840	0.585
Motivation	0.828	0.821	0.835	0.614
Self-confidence	0.817	0.817	0.821	0.605
Study Strategies	0.812	0.811	0.810	0.587
Time Management	0.802	0.799	0.801	0.577

The construct reliability and validity analysis for the Prospective Teachers' Mathematics Study Strategies Scale indicated that all constructs met acceptable reliability and validity thresholds. Cronbach's alpha values, both standardised and unstandardised, ranged between 0.776 and 0.828, demonstrating internal consistency across all constructs. Specifically, Motivation had the highest standardised Cronbach's alpha (0.828), followed by Self-confidence (0.817) and Study Strategies (0.812), while Attitudes and Time Management also showed satisfactory values of 0.776 and 0.802, respectively.

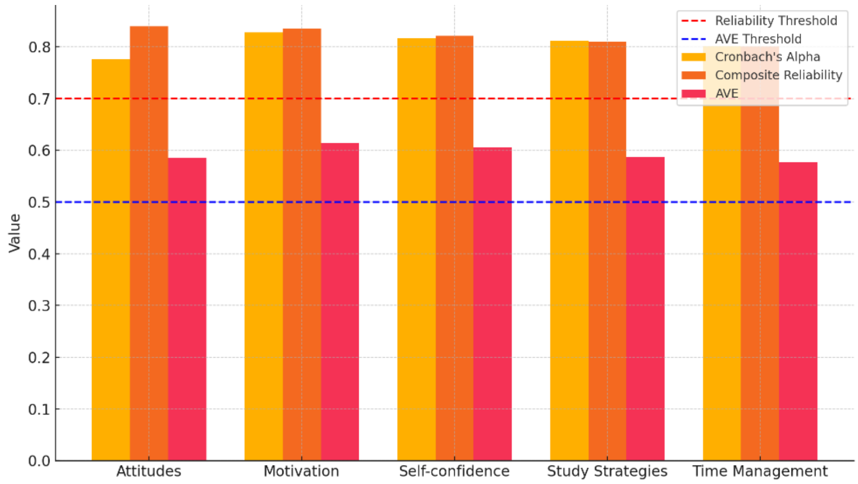
Composite reliability (rho_c) values ranged from 0.801 to 0.840, further confirming the internal consistency of the constructs. The Attitudes construct exhibited the highest composite reliability (0.840), closely followed by Motivation (0.835) and Self-confidence (0.821). These results highlight the robust reliability of the scale in measuring its intended constructs.

The Average Variance Extracted (AVE) values were all above the recommended threshold of 0.50, with values ranging from 0.577 (Time Management) to 0.614 (Motivation). These results demonstrate that each construct captured a sufficient proportion of the variance in its indicators, supporting the convergent validity of the measurement model.

Overall, the scale exhibits strong reliability and validity, making it a reliable tool for assessing prospective teachers' mathematics study strategies and related constructs.

Graph 3

Reliability and Validity Metrics by Construct



The Reliability and Validity Metrics by Construct chart visually highlight the model's constructs' internal consistency and convergent validity. It presents Cronbach's Alpha, Composite Reliability (Rho_c), and Average Variance Extracted (AVE), demonstrating that all constructs meet acceptable thresholds (Alpha > 0.70, AVE > 0.50). This visualisation enhances clarity by providing a quick comparison across constructs, facilitates interpretation by clearly showing adherence to benchmarks, and reinforces the scale's measurement rigour. Its inclusion ensures methodological robustness, which is essential for high-impact journal publications.

Table 5

Discriminant Validity - HTMT

	Attidues	Motivation	Self-confidence	Study Strategies	Time Management
Attidues					
Motivation	0.817				
Self-confidence	0.870	0.792			
Study Strategies	0.762	0.838	0.802		
Time Management	0.753	0.814	0.782	0.839	

The discriminant validity of the Prospective Teachers' Mathematics Study Strategies Scale was assessed using the Heterotrait-Monotrait Ratio (HTMT), and the results indicate acceptable levels of discriminant validity across the constructs. The HTMT values for all construct pairs were below the commonly accepted threshold of 0.90, supporting the distinctiveness of the constructs.

Attitudes exhibited HTMT values of 0.817 with Motivation and 0.870 with Self-confidence, suggesting a moderate level of association while maintaining sufficient distinction. Motivation showed HTMT values of 0.792 with Self-confidence, 0.838 with Study Strategies, and 0.814 with Time Management, reflecting its interconnectedness with other constructs while preserving discriminant validity.

Study Strategies demonstrated an HTMT value of 0.802 with Self-confidence and 0.839 with Time Management, further confirming the distinctiveness of these constructs despite their strong theoretical connections. Similarly, Time Management maintained acceptable HTMT values with all other constructs, reinforcing the discriminant validity of the measurement model.

Overall, the HTMT analysis indicates that the constructs within the scale are sufficiently distinct, ensuring that the scale captures unique dimensions of prospective teachers' mathematics study strategies. This finding supports the robustness of the scale's measurement properties.

Table 6

Model Fit

ChiSqr/df	4.271
RMSEA	0.103
GFI	0.856
AGFI	0.754
PGFI	0.501
SRMR	0.053
NFI	0.881
TLI	0.874
CFI	0.905
AIC	449.373
BIC	658.621

The model fit indices for the Prospective Teachers' Mathematics Study Strategies Scale provide mixed evidence regarding the adequacy of the model's fit. The Chi-Square/df ratio was 4.271, slightly above the commonly recommended threshold of 3, indicating a moderate fit. The Root Mean Square Error of Approximation (RMSEA) value was 0.103, exceeding the threshold of 0.08, which suggests that the model fit could be improved in terms of error approximation.

Other fit indices presented acceptable values. The Goodness of Fit Index (GFI) was 0.856, and the Adjusted Goodness of Fit Index (AGFI) was 0.754, approaching or within acceptable ranges for model fit. The Parsimonious Goodness of Fit Index (PGFI) was 0.501, indicating a lower level of parsimony in the model.

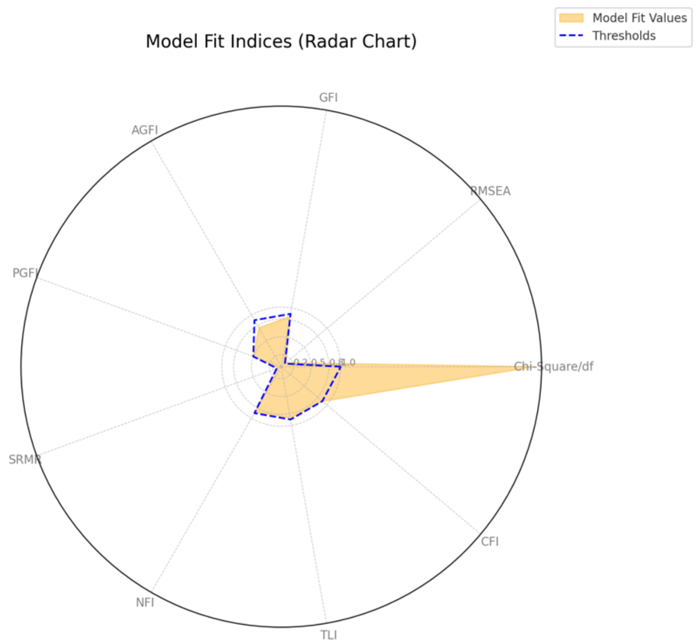
The Standardized Root Mean Square Residual (SRMR), at 0.053, fell below the threshold of 0.08, signalling a good fit for residual differences between observed and predicted covariances. Among the incremental fit indices, the Normed Fit Index (NFI) was 0.881, and the Tucker-Lewis Index (TLI) was 0.874. These were slightly below the recommended threshold of 0.90, indicating a need for minor improvements. The Comparative Fit Index (CFI), however, met the threshold at 0.905, suggesting a strong relative fit of the model.

The model's information criteria, including the Akaike Information Criterion (AIC) of 449.373 and the Bayesian Information Criterion (BIC) of 658.621, provide additional support for model evaluation. However, comparative analysis with alternative models would be required for further interpretation.

While some fit indices, particularly the RMSEA, NFI, and TLI, fell below optimal thresholds, the SRMR, CFI, and other reliability and validity metrics support the scale's construct validity and reliability. These findings indicate that the measurement model is valid mainly and reliable, with minor areas for refinement to improve overall model fit.

Graph 4

Model Fit Indices (Radar Chart)



The Model Fit Indices Radar Chart clearly represents the model's fit by comparing key indices (e.g., RMSEA, GFI, and CFI) against established thresholds. This chart highlights areas where the model meets or exceeds benchmarks and indices requiring improvement, such as RMSEA. Presenting all fit indexes in a single visualisation facilitates quick interpretation and emphasises the overall adequacy of the model's fit. Including this chart enhances methodological transparency and rigour, making it a valuable addition to manuscripts for high-impact journal publications.

DISCUSSION AND CONCLUSION

Developing a scale to measure prospective teachers' mathematics study strategies provides a valuable contribution to mathematics education by addressing essential cognitive, affective, and behavioural dimensions. The five-factor structure—attitudes, Motivation, Self-confidence, Study Strategies, and Time Management—aligns with and extends existing research on self-regulation, motivation, and effective learning strategies in mathematics education.

Comparison with Existing Literature

Self-regulation and motivation are critical components of success in mathematics education. Fazlı and Avcı (2022) highlighted the role of self-determination theory in promoting motivation in mathematics learning, emphasising the importance of satisfying basic psychological needs for fostering sustained engagement. Similarly, Ozyildirim Gümüş (2015) examined problem-solving strategies and self-efficacy in mathematics, finding that prospective teachers employ diverse strategies influenced by their perceptions of self-efficacy. These findings resonate with the dimensions captured in the developed scale, particularly regarding the role of attitudes and self-confidence in shaping study strategies.

Moreover, the scale's emphasis on time management and motivational factors reflects findings from studies by Schunk and DiBenedetto (2020), who argued for integrating motivational constructs into self-regulated learning frameworks to support academic success better. The alignment of these theoretical perspectives with the study’s findings strengthens the scale’s validity as a tool for understanding and enhancing prospective teachers’ learning behaviours.

Methodological Contributions and Applications

The rigorous validation process, including EFA and CFA, ensures the scale's reliability and generalizability. Fit indices, such as CFI = 0.905 and SRMR = 0.053, demonstrate adherence to recommended thresholds for model fit (Hu & Bentler, 1999). These metrics and Cronbach's Alpha values ranging from 0.776 to 0.828 confirm the scale's internal consistency, meeting established reliability criteria.

This scale offers valuable applications in teacher education programs by identifying areas where prospective teachers may need support, particularly in motivation, time management, and self-regulation. For educators, the instrument provides a basis for designing targeted interventions that enhance these critical skills. For researchers, the scale is a validated tool for exploring the interplay of cognitive, affective, and behavioural factors in mathematics education.

Future Research Directions

While the scale has been validated within the context of prospective mathematics teachers, future research could explore its applicability across diverse populations, including in-service teachers and students from different cultural backgrounds. Further, the scale's predictive validity about academic outcomes, such as mathematics achievement or professional teaching efficacy, warrants investigation. Longitudinal studies could provide additional insights into how these constructs evolve, especially as teachers transition into professional practice.

Conclusion

This study contributes to the literature by presenting a reliable and valid instrument for measuring prospective teachers' mathematics study strategies. By capturing the multifaceted nature of these strategies, the scale lays the foundation for future research and interventions to enhance teacher preparation and promote academic success.

Limitations and Future Research

The study's limitations include that the sample was limited to pre-service teachers from a single university. This may limit the generalizability of the scale. In future research, it is recommended that validity and reliability studies of the scale be conducted in different educational contexts and cultural settings (Brown, 2009; Büyüköztürk, 2018). In addition, the study only collected data based on self-reports, which may increase the risk of bias. Observational methods or performance-based measures can contribute to a more robust grounding of findings (Kilpatrick et al., 2001).

Contributions to Education and Research

This study provides a reliable and valid scale to assess pre-service mathematics teachers' cognitive, motivational and metacognitive strategies. The scale can be used as an effective tool not only in understanding the individual development processes of pre-service teachers but also in improving teacher training programs (Aydın & Özdemir, 2022; Güneş & Özdaş, 2023). Continuous updating of the scale, especially in adapting to changes in educational technologies and methods, has significant potential for future research.

Ethical approval

The Ethics Committee for Scientific Research in Social and Human Sciences of xx University issued a decision (No: xx/xx) stating that there is no ethical objection to implementing the research.

Conflict of Interest

The authors have no conflict of interest to declare

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Matematik Çalışma Stratejileri Ölçeği

• Aşağıdaki ifadeleri okuyun ve size ne kadar uygun olduğunu düşünerek 1'den 5'e kadar olan seçeneklerden birini işaretleyin.

• (1 = Kesinlikle Katılmıyorum, 5 = Tamamen Katılıyorum)

Motivasyon

1. Matematik dersi çalışmalarımda başarılı olmak benim için önemlidir.

2. Matematik dersi çalışmaktan keyif alıyorum.

3. Matematik çalışırken hedeflerimi belirleyip o doğrultuda ilerlerim.

Zaman Yönetimi

4. Matematik çalışmak için belirli zaman aralıkları ayırırım.

5. Matematik çalışmak için programımı düzenlerim.

6. Matematik çalışmak için hazırladığım planlara düzenli olarak uyarım.

Çalışma Stratejileri

7. Matematik sorularını çözmek için farklı teknikler kullanırım.

8. Matematik konularını anlamak için önceki notlarımı ve ödevlerimi gözden geçiririm.

9. Karmaşık problemleri daha küçük ve yönetilebilir parçalara bölerim.

Tutumlar

10. Matematik problemlerini çözerken kendime güvenirim.

11. Matematik çalışmayı bunaltıcı buluyorum. (Ters Madde)

12. Kesinlikle gerekmedikçe matematik çalışmaktan kaçınırım. (Ters Madde)

Kendine Güven

13. Matematik görevlerinde başarılı olacağıma inanıyorum.

14. Matematikte problem çözme becerilerime güveniyorum.

15. Matematik konularını anlamada genellikle kendimden şüphe duyarım. (Ters Madde)

Puanlama Yönergesi

Her madde 1'den 5'e kadar puanlanır, burada:

1 = Kesinlikle Katılmıyorum
2 = Katılmıyorum
3 = Kararsızım
4 = Katılıyorum
5 = Tamamen Katılıyorum

Ters maddeler için puanlar ters çevrilmelidir:
1 puanı 5 olur, 2 puanı 4 olur, 3 puanı aynı kalır, 4 puanı 2 olur ve 5 puanı 1 olur.

Mathematics Study Strategies Scale

• Read the following statements and indicate how much you agree with each one by selecting a number from 1 to 5.

• (1 = Strongly Disagree, 5 = Strongly Agree)

Motivation

1. Being successful in mathematics studies is important to me.

2. I enjoy studying mathematics.

3. I set goals while studying mathematics and work towards them.

Time Management

4. I allocate specific time slots to study mathematics.

5. I organize my schedule to study mathematics.

6. I consistently follow the plans I prepare for studying mathematics.

Study Strategies

7. I use different techniques to solve mathematics problems.

8. I review my previous notes and assignments to understand mathematics topics.

9. I break down complex problems into smaller, manageable parts.

Attitudes

10. I feel confident when solving mathematics problems.

11. I find studying mathematics overwhelming. (Reversed Item)

12. I avoid studying mathematics unless absolutely necessary. (Reversed Item)

Self-Confidence

13. I believe I will succeed in mathematics tasks.

14. I trust my problem-solving skills in mathematics.

15. I often doubt my ability to understand mathematics topics. (Reversed Item)

Scoring Instructions

Each item is rated on a scale from 1 to 5, where:

1 = Strongly Disagree
2 = Disagree
3 = Neutral
4 = Agree
5 = Strongly Agree

For reversed items, scores should be inverted:
1 becomes 5, 2 becomes 4, 3 remains 3, 4 becomes 2, and 5 becomes 1.